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UNDERSEA VOLCANO PRODUCTION VERSUS LITHOSPHERIC STRENGTH FROM SATELLITE ALTIMETRY

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PROGRESS REPORT

During the first six months of the funding period (NAG5-787) we have concentrated on three areas of research. A more complete progress report (including publications) will follow when we apply for a second year of funding to complete the research.

LOCATING AND DIGITIZING SEAMOUNTS

We have located and digitized all seamount signatures apparent in the Seasat altimeter profiles. The seamounts, that we were able to detect, have peak to trough vertical deflection amplitudes greater than 10μrad (i.e. about 10 mgal). These vertical deflection amplitudes correspond to seamounts that are more than 1km tall. Approximately one third, of the 8556 seamount signatures that we have identified, correspond to previously uncharted features. Therefore this initial phase of our research has resulted a significant improvement in our understanding of the global distribution of seamounts.

In addition to locating these seamount signatures, we have also estimated their amplitudes. Figure 1 shows the seamounts that we have located. The size of each cross is proportional to the amplitude of the seamount signature. The geophysical significance of the distribution of the seamounts and their amplitudes as well as the accuracy of our results will be contained in the next progress report. (Publication 1, below)

ESTIMATING SEAMOUNT CHARACTERISTICS FROM ALTIMETER PROFILES

The second phase of our research has been to determine what basic characteristics of a seamount can be extracted from a single vertical deflection profile. Simple flexural models for a seamount predict that the characteristic diameter of a seamount is equal to the distance between the peak and the trough in the vertical signature. The model also predicted that the satellite profile would correctly measure the diameter of the seamount even if the satellite did not pass over the summit of the seamount. This result is important because it implies that incomplete satellite coverage is useful for measuring seamount diameters.

To test the model, we used 7 seamounts that had both good bathymetric coverage and good satellite altimeter coverage. We then measured the diameter of the seamount half way between the

base and the summit. Most of these seamounts were intersected by more than one satellite profile. After measuring the distance between the peak and trough we compared this distance with the actual seamount diameter. The results are shown in Figure 2. If the two diameters matched the points would lie on the dashed line with a slope of 1 and a intercept of zero. The results are very encouraging and show agreement to an accuracy of 10km. (Publications 2 and 3)

- CREATING DETAILED AND ACCURATE GEOIDS

The final aspect of our progress was to develop techniques for creating detailed and accurate geoids. The main limitation of Seasat data is it rather coarse ground track spacing. We have developed a method of combining satellite altimeter profiles from several different satellites (e.g. Geos-3, Seasat, Geosat and Topex) to construct a detailed and accurate geoid. No crossover adjustment is necessary for this new method. We have suppressed the radial orbit error by taking the along-track derivative of each profile. These slope vectors were then combined into a consistent geoid. Results for the Caribbean area are shown in Figure 3. The first image shows the geoid height constructed using all Geos-3 and Seasat data. The second image is the bathymetry of the area. The high correlation between the two images indicates that the high frequency undulations in the geoid are real and are due to seafloor topography. (Publication 4)

PUBLICATIONS

1) Craig, C. H. and D. T. Sandwell, the distribution in the world's oceans from satellite altimetry, to be submitted to Geophys. Res. Lett., 1987.

2) Sandwell, D. T., Undersea volcano production versus lithospheric strength from satellite altimetry, EOS, v. 67, p. 372, 1986.

3) Sandwell, D. T. and C. H. Craig, Measurements of undersea volcanoes from satellite altimeter profiles, to be submitted to Geophys. Res. Lett., 1987.

4) Sandwell, D. T., Biharmonic spline interpolation of Geos-3 and Seasat altimeter data, Geophys. Res. Lett., in press, 1987.

Seamounts Amplitudes (.0008 in/μRad)

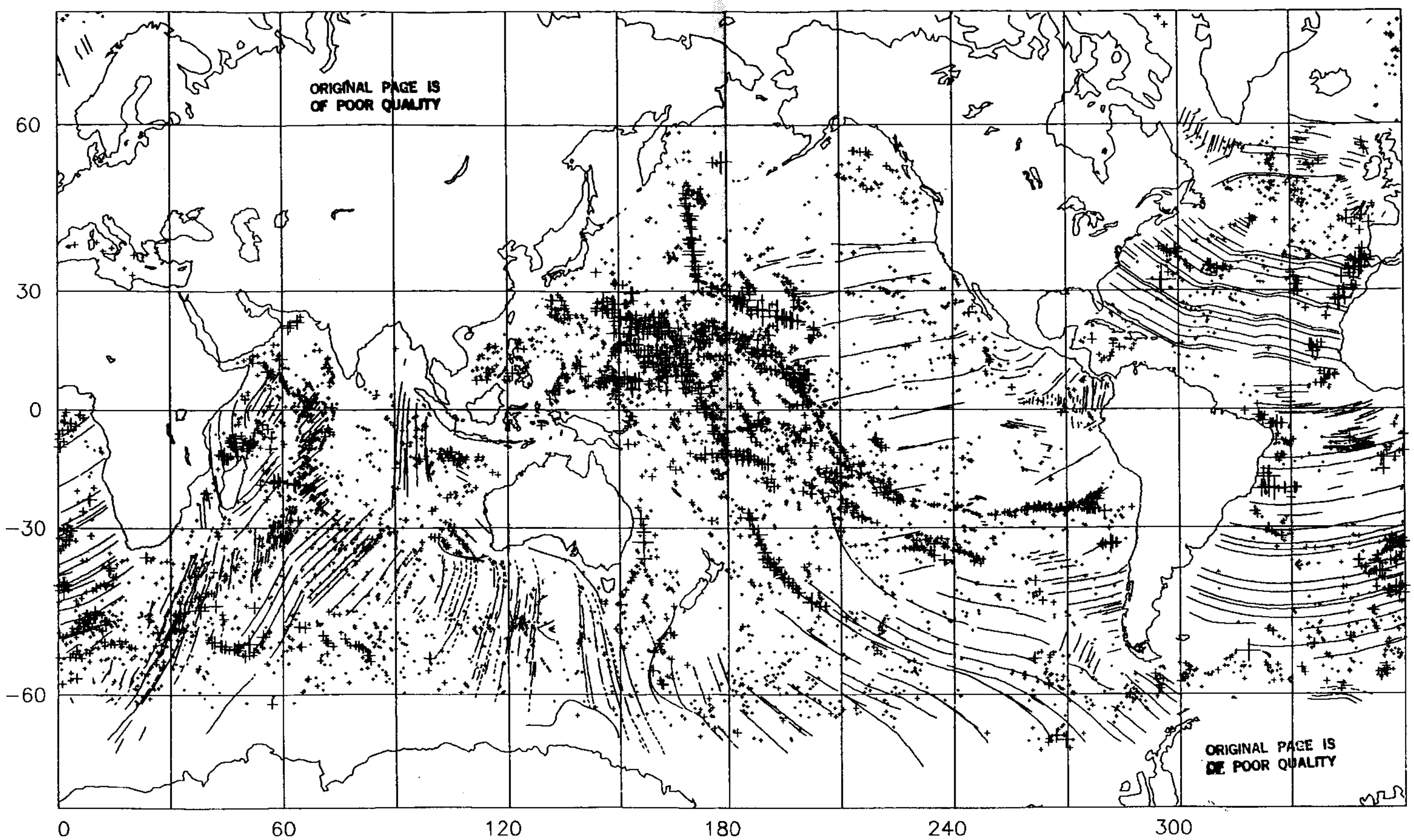

Fig. 1. Global distribution of seamounts in the world's oceans derived from Seasat altimeter data. The size of each cross is proportional to the peak to trough vertical deflection signature. Approximately one third of these seamounts were previously uncharted.

1 FOLDOUT FRAME

2 FOLDOUT FRAME

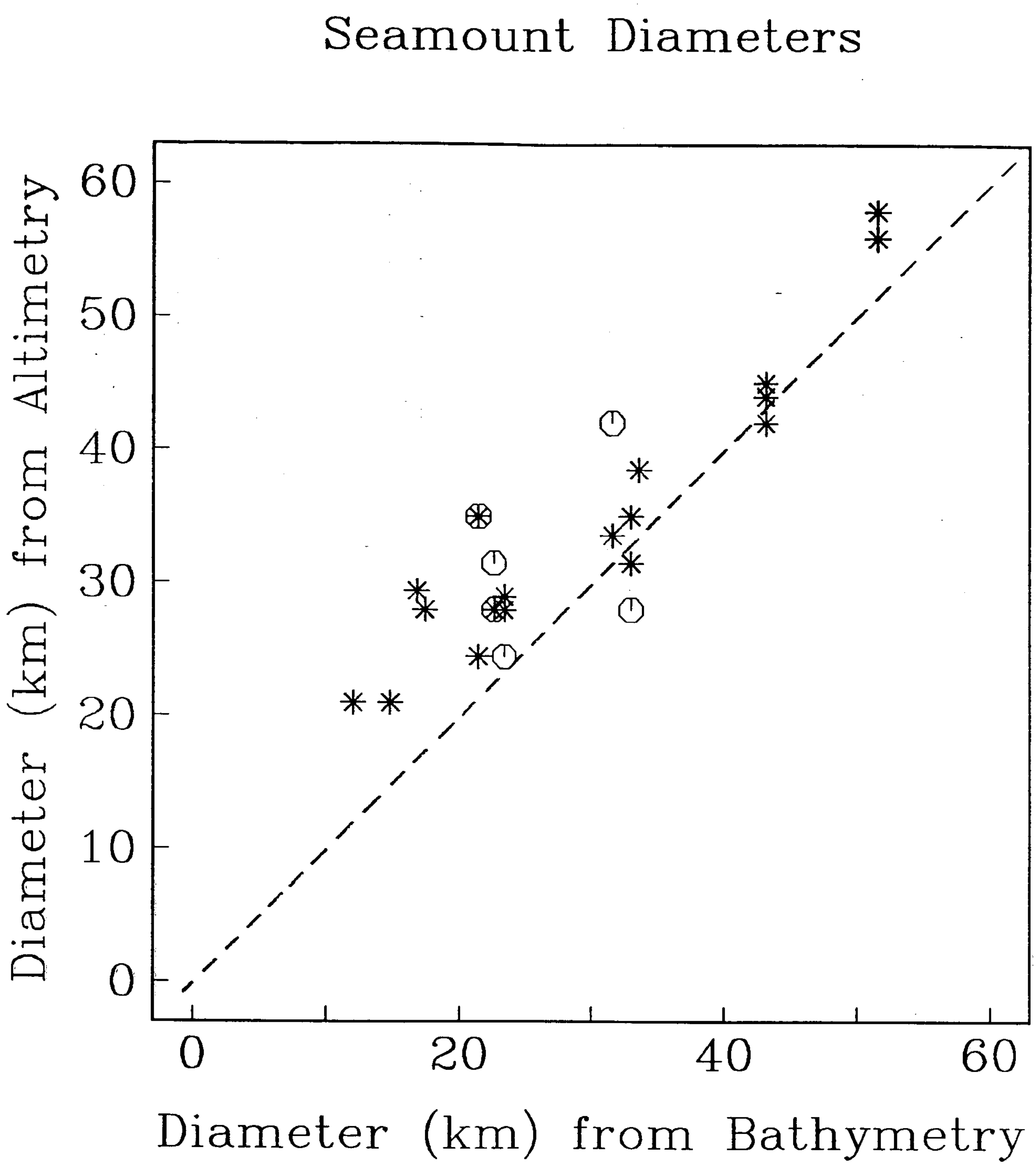

Fig. 2. Diameter of seamount derived from single altimeter profiles versus actual seamount diameter. Seven well surveyed seamounts were used for this test. Results suggest satellite altimeter profiles can be used to measure diameters of unsurveyed seamounts to an accuracy of 10km.

Geoid Height

Fig 3

Bathymetry

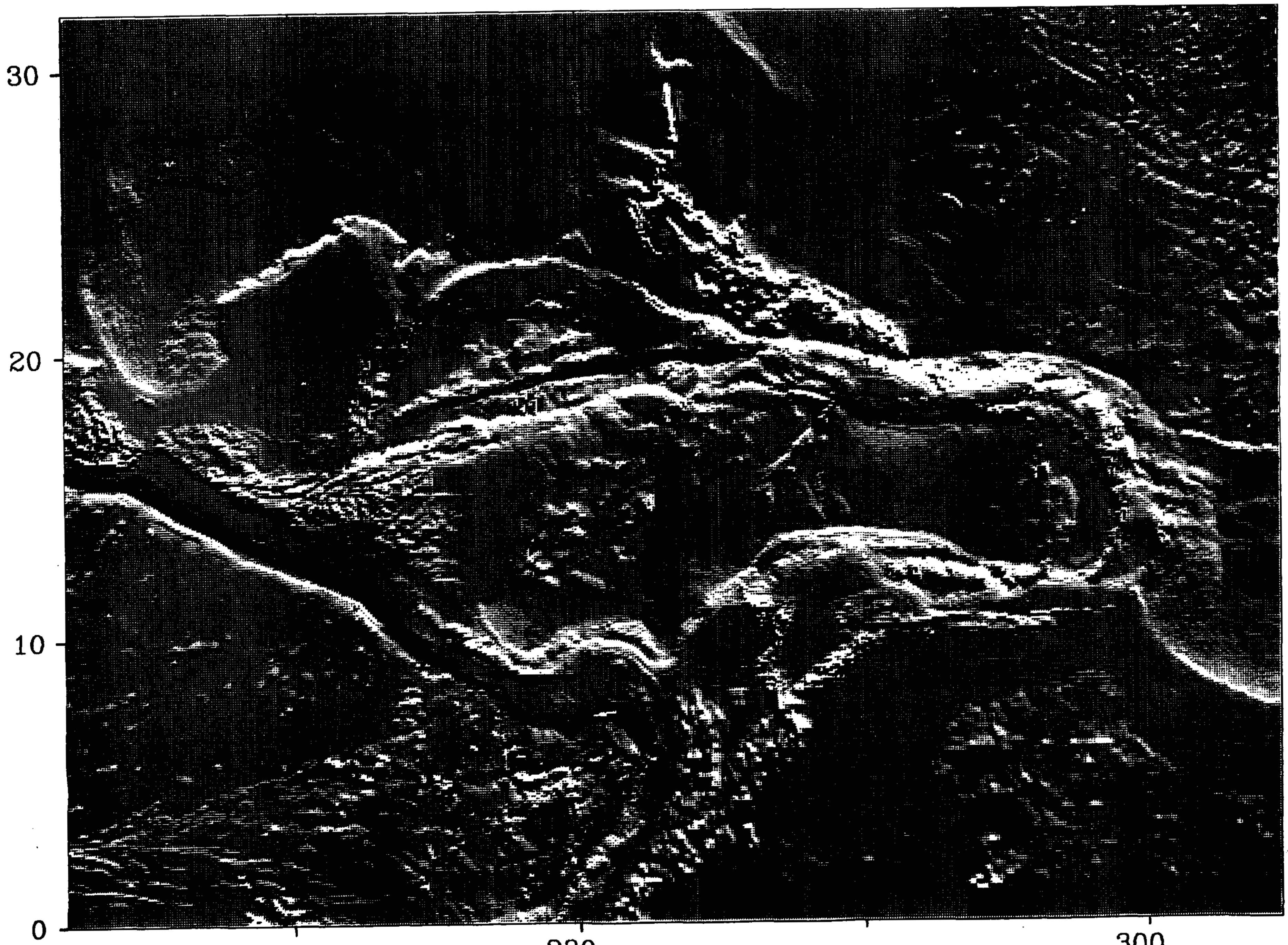

Fig 3